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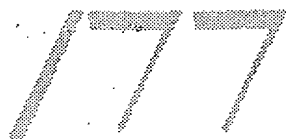
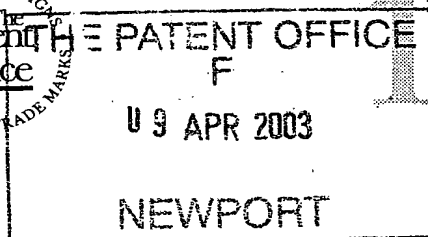
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DY3118

09APR03 E798951-1 D00370

P01/7700 0.00-0308170.0

2. Patent application number

(The Patent Office will fill in this part)

0308170.0

6-9 APR 2003

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)

ROLLS-ROYCE PLC
65 BUCKINGHAM GATE
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SW1E 6AT

Patents ADP number (*if you know it*)

3970002 IS

If the applicant is a corporate body, give the country/state of its incorporation

ENGLAND

4. Title of the invention

A MOUNTING ARRANGEMENT AND METHOD

5. Name of your agent (*if you have one*)

M A GUNN

"Address for service" in the United Kingdom to which all correspondence should be sent (*including the postcode*)

ROLLS-ROYCE plc
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PO BOX 31
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DE24 8BJ

Patents ADP number (*if you know it*)

3962001

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Country

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Date of filing
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Number of earlier application

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YES

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Description

11

Claim(s)

2

Abstract

1

Drawing(s)

2 2 8

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Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

2

Request for preliminary examination and search (Patents Form 9/77)

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Request for substantive examination (Patents Form 10/77)

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ROLLS-ROYCE plc

CASE NO: DY3118

RR TITLE: 

APPLICATION NO:

DATED: 9 APRIL 2003

FIRST APPLICATION

DRAFTED BY: S&P FOR PDG

PATENTS ACT 1977

SPECIFICATION

A MOUNTING ARRANGEMENT AND METHOD

DUPLICATE

A Mounting Arrangement and Method

5 The present invention relates to mounting arrangements
for and methods of machining components such as turbine
discs and compressor discs which may retain residual
stresses after initial forging.

A number of components are initially cast or forged
into an approximate shape for the final finished component.
10 Such an approach allows ease of manufacture as well as
potential crystallography and material treatment to be
achieved conveniently. The forged component such as a
turbine disc is then machined appropriately in order to
achieve the final component shape and surface finish.
15 Generally the original forged component only provides a
rough approximation to the final finished shape and so a
significant proportion of the forged material must be
removed in order to achieve the desired finished shape.

Machining of the forged component is typically through
20 milling, turning or broaching whereby material is removed
from the rough forged component until the desired finished
shape is achieved. For example, Heyligenstaedt four-axis
turning machines are known for providing the final
machining of rough forged components into desired
25 compressor discs. Unfortunately, these machines are
designed for high accuracy operation such that multiple
abutment clamping of the component is necessary and
normally a datum such as a flat surface is initially
provided to the component to ensure surety of position and
30 therefore machined accuracy in the final product. Such
robust and accurate assembly as indicated is highly
beneficial with regard to high accuracy machining processes
but with regard to machining initially rough forged
components may be detrimental.

It will be understood that forged components generally retain residual stresses arising from the forging or casting process. These residual stresses cannot be relieved in the above forged component due to the high strength clamping inherent in machines such as Heyligenstaedt four-axis turning machines for accurate forming. In such circumstances, when the multi abutment clamping is released the final machine component may become distorted as these residual stresses are then relieved. Such distortion clearly detracts from the desired shape profile for the component in its finished state.

In accordance with the present invention there is provided a mounting arrangement for machining components which may retain residual stresses, the arrangement comprising multiple point contact abutment clamping in use of a component, the arrangement characterised in that only three clamp pairs are provided to enable residual stress relief in use as the component is machined and incorporating a damper to augment vibration control otherwise diminished by the reduced contact clamping provided by only minimal contact abutment.

Preferably, each clamp pair is provided by opposed pairs of a clamping pad and a seating pad either side of the component. Typically, the clamping pad and/or the seating pads are configured for consistency with the presented component profile. Furthermore, such consistency may ensure appropriate approximate configuration of the component within the mounting arrangement. Advantageously, each clamp pair is adjustable in terms of presentation relative to the component.

Preferably the damper is perpendicular to the axial direction of contact abutment. Advantageously, the damper comprises a hydraulic ram and the damper member is held in contact with the component by a force. Typically, the

force will be variable. Generally, the force applied by the damper will be controlled dependent on sensed vibration and/or machining process step/regime and/or current process step and/or to facilitate an anti-phase cancellation
5 oscillation within the component to harmonic vibration beats. Normally the damper will comprise a contact finger. This contact finger may be made from elastomeric material or a metal contact or any other suitable means of providing contact for vibration de-coupling.

10 Also in accordance with the present invention there is provided a method of machining components which may retain residual stresses, the method comprising clamping a component with multiple point abutment contacts and there
15 after machining the component, the method characterised in that the component is only clamped by three clamp pairs and a vibration damper is applied to the component in order to augment vibration control due to machining of the component otherwise diminished by reduced contact abutments.

Typically the method in accordance with the present
20 invention comprises an initial machining process for removal of bulk material from a rough initial component and a final machining process with more resilient clamping of the component for more accurate machining of that component.

25 Generally, each clamp pair in accordance with the mounting arrangement and/or the method as described above allows slip movement of the component within the clamp pairs to relieve residual stresses within that component during machining.

30 An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 is a schematic half cross-section of a mounting arrangement about a centre line X-X;

Fig. 2 is a schematic plan view of a whole mounting arrangement in the direction X-X depicted in Fig. 1; and,

Fig. 3 is a side view of the arrangement depicted in Fig. 2.

5 Referring to Fig. 1 which is a schematic cross-section of a mounting arrangement 1 in accordance with the present invention. Thus, the arrangement 1 comprises a clamp pair formed by abutment contact between a clamping pad 2 and a seat pad 3. The clamp pair creates a contact abutment in
10 order to clamp a component 4. This component 4 as illustrated in Fig. 1 is initially a rough forged component with an outline profile 5 but upon machining by means not depicted is rendered with a finished profile 6. Such machining can be by turning or other technique as required.
15 The component will be turned relative to a tool.

In order to provide clamping force an axial movement in the direction of arrowhead A is provided such that contact abutment is achieved between the clamping pad 2 and seating pad 3. Generally, this axial movement in the
20 direction of arrowhead A will be through a screw thread 7 driven by a worm gear or otherwise in order to create the necessary clamping force across the pair of clamping pad 2 and seating pad 3.

In accordance with the present invention a damper 8 is
25 provided which engages the component 4 in order to achieve vibration control. The damper 8 comprises a hydraulic ram 9 with a damper member 10 extending downwards into contact with a surface 11 of the component 4. Thus the damper 8 will damp vibrations created within the component 4 as it
30 is machined from the initial rough forged profile 5 to the finished profile 6.

In accordance with the present invention a minimum number of clamp pairs are provided in order to allow relief of residual stresses created within the component 4 as a

result of the forging or casting process. The minimum number of clamp pairs is three. Contact abutments created across opposed clamp pairs will normally be arranged with a 120° angle between clamp pairs, as the component 4 is round. The number of clamping pairs provided will be three to present the component 4 to the appropriate turning device rather than resiliently secure consistent presentation of that component 4 throughout machining for accurate determination of the final profile 6. In such circumstances residual stresses within the component 4 can be relieved by slip movement or other relief about the pads 2, 3 and between the clamping pairs created between the clamping pads 2 and seating pad 3. Residual stresses can be relieved during machining and upon release of the finished or part finished component from the present clamping pairs there is less distortion of that component from the final machined shape 6.

In previous systems eight or more clamping pairs have been provided in order to mount the component with sufficient resilient strength for consistent presentation but such resilient securing of the component 4 prevents relief of residual stresses in the component 4 during machining processes.

By provision of the minimum number of clamping pairs to present the component to the machining device it will be understood that the component is thereby able to adjust in order to release the residual stresses caused by the forging process but also unfortunately will tend to vibrate to a far greater extent. Thus, the damper 8 augments vibration control previously achieved through multipoint contact abutments with generally in excess of eight clamping pairs. In such circumstances the detrimental affects of vibration within the component 4 as it is machined from the initial rough profile 5 to the finished

6
profile 6 are inhibited. Vibration itself may cause erroneous machining of the component 4 so that such vibration control is necessary.

5 The present invention provides a "looser" presentation of the component 4 to the machining device to allow relief of residual stresses but incorporates provision of a damper 8 in order to control vibration in association with the remaining clamping abutment contacts across a mounting end of the component 4.

10 Referring to Figs. 2 and 3 which schematically illustrate the mounting arrangement 1 in accordance with the present invention. Thus, three clamping pairs constituted by pads 2, 3 are provided to support the component 4 in an appropriate orientation so that the
15 component 4 may be turned in order to machine an area 20 to an appropriate profile. As indicated previously, the component 4 is generally rotated about an axis X-X. By providing three clamping pairs at equal spacing around the component 4 it will be understood that the component is
20 thereby reliably mounted but with an ability to adjust for stress relief. Typically, the component 4 will be a disc secured within a substantially vertical orientation with turning tools extending inwardly to machine the area 20. These tools would be presented in an opposed orientation
25 either side of the component 4 for balance. Generally, the clamping pairs will be adjusted to ensure appropriate vertical presentation of the component 4 for turning and machining purposes. As indicated in Fig. 3, generally the turning process will remove material from areas 21 in order
30 to shape the component 4 appropriately.

Three or more damper members 10 are generally associated in physical contact with component 4 in order to provide vibration control. As indicated above, such vibration control and contact can be through any

appropriate association such that the members 10 may be metal fingers or elastomeric contacts in appropriate engagement with the component 4. Damping control in accordance with the present invention is necessary due to
5 the much reduced resilience provided by only the minimal three clamping pairs provided.

Although only three clamping pairs are utilised in accordance with the present invention, it will be appreciated that these pairs will still hold the component,
10 4 and so inhibit relief of some stress retained within the component 4 as a result of the forging or casting process. In such circumstances, it is preferred in accordance with the present invention to initially turn the component held by the three clamping pairs to an approximation of the
15 desired final profile. Generally, this approximation will be within less than a millimetre of the desired final profile. Once in the approximation to the final profile the clamping pairs through pads 2, 3 will be released to allow the component to relax. This relaxation may result
20 in the component 4 expanding due to stress relief. Clearly, different components 4 will require different periods of time in order to relax for stress relief but nevertheless, after an appropriate period the component 4 will be remounted within the mounting arrangement 1 with
25 the three clamp pairs and the component then finally turned to the final desired profile 6 (Fig. 1).

As the component 4 is mounted by the clamping pairs through pads 2, 3 it will be understood that a rim periphery area 22 of the component 4 cannot be machined due
30 to interference with these pads 2, 3. In such circumstances, normally the component 4 will be released from the present mounting arrangement 1 and mounted in an alternative arrangement to allow appropriate machining of the component 4 in this area 22. This machining may

include milling, broaching or other techniques in order to create appropriate rim structures for the component 4. Normally, the rim structure of the component 4 will have a much greater cross-sectional diameter in comparison with the relatively thin area 20 turned into a final profile whilst in the mounting arrangement 1. Thus, such more substantial structural thickness for radial dimension will limit the effects of residual stresses within the component in this area 22 of the component 4.

In view of the above, it will be appreciated that machining of a component 4 in accordance with the present invention will typically be of only two major operation cycles. A first utilising the present mounting arrangement 1 with only three clamping pairs in order to create the thin central wall of the component 4 in the area 20 and a second operation cycle in order to create the rim structures such as blade mounting grooves, etc.

As indicated in Fig. 1 generally the damper 8 is arranged to be substantially perpendicular to the component 4. Such an arrangement is convenient in terms of accommodation within the clamping arrangement 1 and as depicted in Fig.1 is generally consistent with the major plane of the component 4. In such circumstances, the damper 8 will provide appropriate vibration control without impinging upon the surfaces of the component 4 which must be machined from the initial rough profile 5 to the final profile 6.

The damper 8 as indicated previously will typically comprise a hydraulic ram which extends the damper member 10 towards the surface 11 of the component 4. The force supplied or vibration absorption achieved through the damper member 10 and ram 9 may be variable. Such variability in vibration absorption and therefore control will render the clamping arrangement 1 more effective with

regard to actual vibration rather than predicted vibration. In such circumstances, the force supplied through the hydraulic ram 9 in order to create vibration control may be determined through sensing vibration within the component 4 and/or machining device process schedule in terms of current machining step as well as predictive anti-phase vibrations presented through the damper member 10 cancelling vibrations within the component 4 caused by machining operations. Possibly, the damper member 10 will be made from an elastomeric material such as rubber but any device which can engage into vibrational contact will be acceptable.

As indicated previously the number of clamping pairs which form contact abutments in accordance with the present invention will generally be limited to three which is the minimum to present the component 4 for appropriate machining but with sufficient laxity to allow the residual stress relief within the component 4 through the machining cycle. In such circumstances as described the minimum number of contact abutments is generally three in an approximate 120° relationship to each other. However, the specific number of contact abutments may be determined by actual requirements with the damper 8 supplementing in terms of vibration control and under performance by the reduced robustness of such clamping compared to previous arrangements.

A number of dampers are normally provided in engagement with the component 4 in order to achieve appropriate vibration control in association with the abutment contacts in clamping pairs in accordance with the present invention. The positioning of dampers may be determined by the particular shape of the component 4.

The present invention also incorporates a method of machining components from a rough profile 5 to a final

profile 6. The method incorporates mounting the component 4 in a clamping arrangement 1 such that there is the minimum number of contact abutments provided as opposed clamping pairs to present the component 4 for appropriate machining. Dampers 8 are then presented to the component 4 in order to augment vibration control achieved by the clamping pairs. In such circumstances, the component 4 subjected to the turning process can relieve residual stresses formed within the component 4 during initial forging or casting processes. The dampers 8 prevent vibration diminishing significantly machining accuracy to the final profile 6. In such circumstances, when the component 4 in the final profile 6 is released from the clamping arrangement 1 the residual stresses within the component have not been retained by the clamping arrangement 1 and so there is less if any distortion of the final profile 6 compared to the desired profile. However, advantageously, the method of the present invention may be used in order to achieve approximation of the final profile 5 using the present method in a first step and mounting arrangement and then the component 4 transiently released from that mounting arrangement and re-secured for a second step of accurate fine turning to the final profile 6. In such circumstances the bulk of residual stresses within the original component 4 and profile 5 are relieved by the present method.

Also in accordance with the present invention there is provision for further machining of the component 4 in order to create rim structures. Thus, the component 4 will be mounted in accordance with the arrangement 1 in order to provide initial turning and machining of the component 4 to the desired profile and then these mountings released and the component 4 mounted in an alternative arrangement in order to provide for machining such as milling, broaching

or another technique in order to create the rim structures as required. In such circumstances, the component 4 is appropriately machined by substantially only 2 machining processes as compared to the far greater number of 5 machining stages previously. It will also be appreciated that other structures could be machined into the component 4 in addition to rim structures.

The present invention allows by the arrangement or method accurate machining of a component 4 to a final 10 profile 6. Previously, in order to avoid the problems of distortion due to residual stresses within the component 4 it was not unusual to machine a component 4 in four or more processing steps whereby the component 4 is initially machined and then released to allow the distortion to 15 residual stresses and then the clamp/machine process again repeated until the final profile is achieved. The present invention allows closer approximation to that final profile or even achievement of that final profile with reduced machining steps and intervening release of the component to 20 relieve residual stresses. In such circumstances, the present arrangement and method facilitate greater efficiency of component machining operations from originally forged components.

Whilst endeavouring in the foregoing specification to 25 draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not 30 particular emphasis has been placed thereon.

CLAIMS

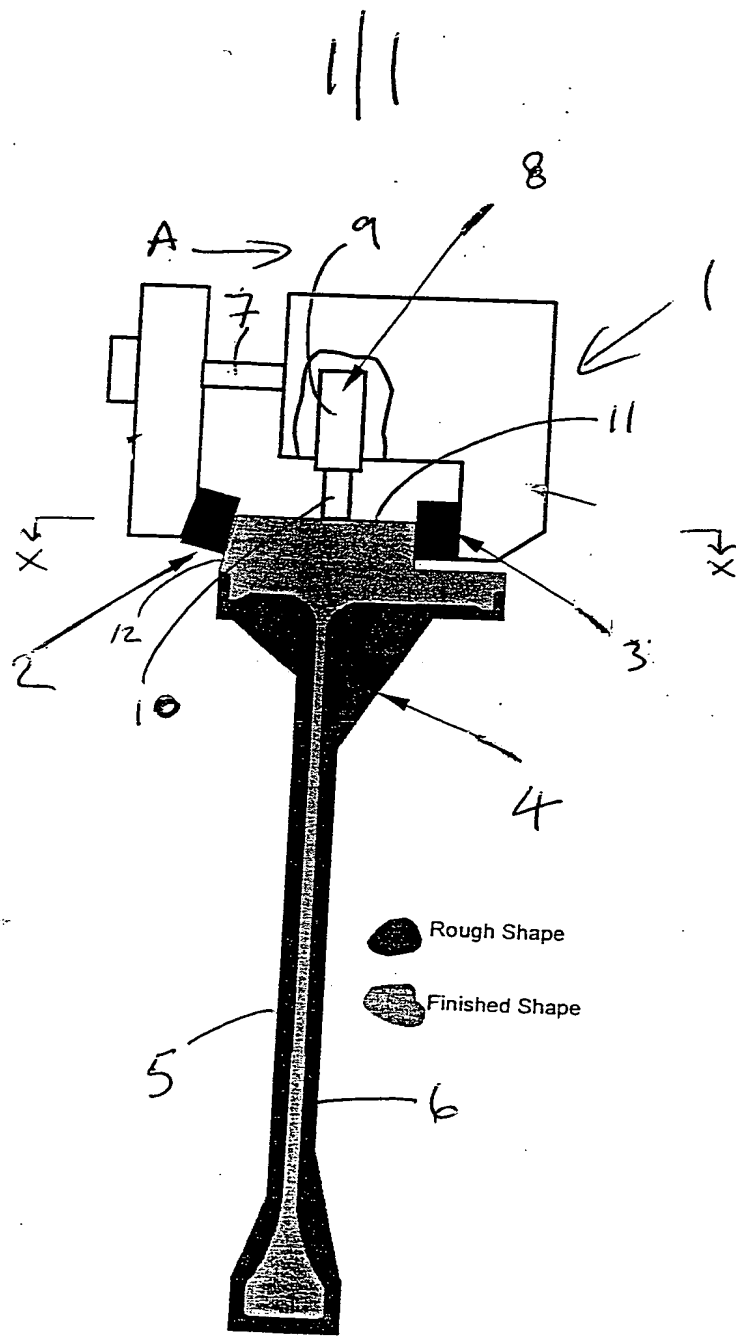
1. A mounting arrangement 1 for machining components 4 which may retain residual stresses, the arrangement
5 comprising multiple point contact abutment clamping in use of a component, the arrangement characterised in that only three clamp pairs are provided to enable residual stress relief in use as the component is machined and incorporating a damper 8 to augment vibration control
10 otherwise diminished by the reduced contact clamping provided by only minimal contact abutments.
2. An arrangement as claimed in claim 1, wherein each clamp pair is provided by opposed pairs of a clamping pad 2 and seating pad 3 either side of the component.
- 15 3. An arrangement as claimed in claim 2, wherein the clamping pad and/or the seating pad are configured for consistency with the presented component profile.
4. An arrangement as claimed in claim 3, wherein such consistency may ensure appropriate approximate
20 configuration of the component within the mounting arrangement.
5. An arrangement as claimed in any preceding claim wherein each contact abutment is adjustable in terms of presentation relative to the component.
- 25 6. An arrangement as claimed in any preceding claim wherein the damper is perpendicular to the axial direction of contact abutment.
7. An arrangement as claimed in any preceding claim wherein the damper comprises a hydraulic ram 9 and the
30 damper member 10 is held in contact with the component by a force.
8. An arrangement as claimed in claim 7 wherein the force will be variable.

9. An arrangement as claimed in claim 7 or 8 wherein the force applied by the damper will be controlled dependent on sensed vibration and/or machining process step/regime and/or current process step and/or to facilitate an anti-phase cancellation oscillation within the component to harmonic vibration beats.
10. An arrangement as claimed in any preceding claim wherein the damper will comprise a contact finger 10 of elastomeric material.
- 10 11. A mounting arrangement substantially as hereinbefore described with reference to the accompanying drawings.
12. A method of machining components 4 which may retain residual stresses, the method comprising clamping a component 4 with multiple point abutment contacts and there
15 after machining the component, the method characterised in that the component is only clamped by three contact abutments 2, 3 and a vibration damper 8 is applied to the component in order to augment vibration control due to machining of the component otherwise diminished by reduced
20 contact abutments.
13. A method as claimed in claim 11, wherein the method comprises an initial machining process for removal of bulk material from a rough initial component and a final machining process with more resilient clamping of the
25 component for more accurate machining of that component.
14. A method substantially as hereinbefore described with reference to the accompanying drawings.
15. Any novel subject matter or combination including novel subject matter disclosed herein, whether or not
30 within the scope of or relating to the same invention as any of the preceding claims.

ABSTRACTMounting Arrangement and Method

5

A mounting arrangement 1 is provided in which clamping pairs comprising a clamping pad 2 and seating pads 3 are arranged about a mounting end of a component 4. Thus, the component 4 is appropriately presented to a machining
10 device but the component 4 can slip relative to the pads 2, 3 in order to relieve residual stresses in the component due to initial forging processes. A damper 8 is provided in order to augment vibration control in association with the contact abutments between the pads 2, 3. In such
15 circumstances accurate machining of a component 4 to a final profile 6 from an initial rough profile 5 can be achieved more efficiently without periodic release of the component 4 so that distortions are avoided in the final component as a result of retained residual stresses by
20 previous clamping.



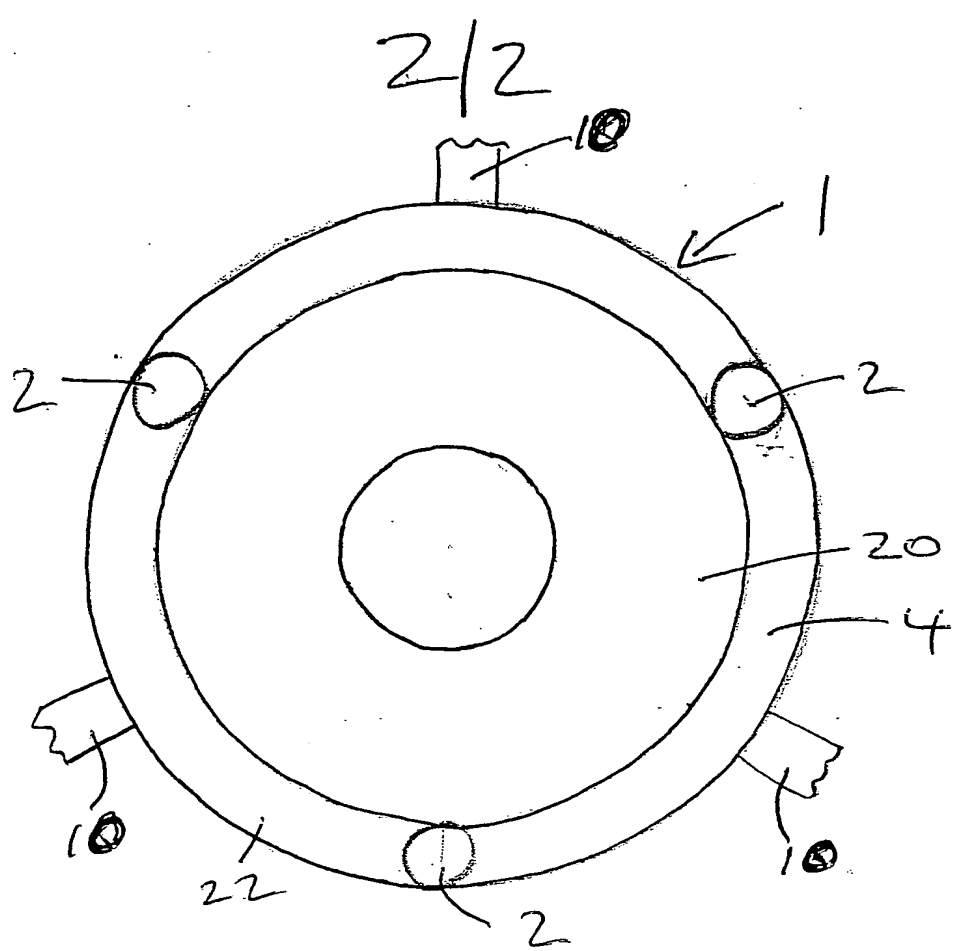


Figure 2

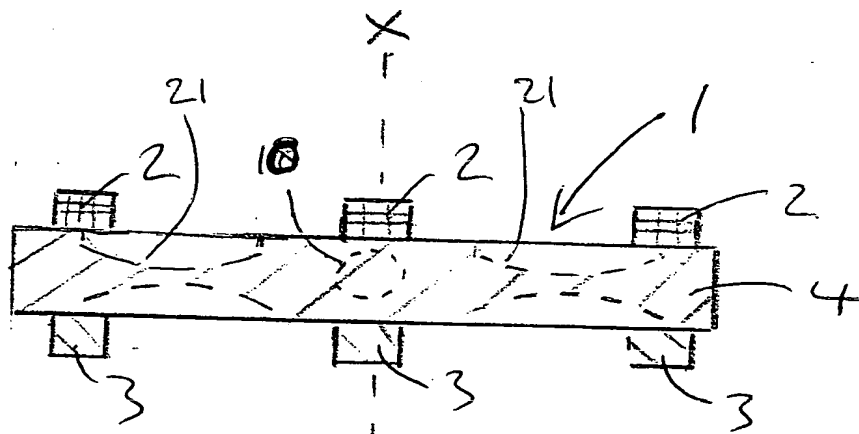


Figure 3